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Name of the invention: Molding Die For A Substrate For Data Recording Medium
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Publicized Report of Patent

Detailed Report

1. Name of the invention

Molding Die For A Substrate For Data Recording Medium

2. Sphere of application of patent

(claim 1)

In the field of injection molding synthetic resin substrates for data recording media, this invention is regarding a mold where the rear side of the mold cavity is hollow and the cavity can be deformed elastically by molding pressure.

3. Detailed explanation of the invention

(field of industrial use)

This invention is regarding molding die of substrate for data recording medium which consists of synthetic resin that is suitable for use of substrates of magnetic disc, optical disc.

(Prior art)

A former manufacturing method for synthetic resin substrates for data recording media is described in Japan patent No. S 60-67124. According to this method, in the process of injection molding the substrate from melted resin, the mold cavity gets continuously thicker in the radial direction of molding cavity as the cavity gets farther from the gate. The intent is to form a substrate with a uniform thickness distribution in all directions and excellent shape stability.

(Problems that this invention tries to solve)

However, according to the former method, it is very difficult to make a mold cavity which continuously changes thickness in the radial direction with the required accuracy.

The substrate formed by the former method will have the same thickness at the inner diameter and outer diameter, it is difficult to get rid of discrepancies due to shrinkage in the middle part between the ID and OD. Quite often the surface will end up being concave in the radial direction as shown in figure 7.

Accordingly, when a magnetic disc is manufactured using a substrate with this shape, the floating height (H2) of the magnetic head will be high. This magnetic disc will have low output as explained in the following.

Figure 6 is a model which shows identical magnetic heads 2 floated 0.4 μm above a magnetic disc 1. It shows substrates with three different shapes – flat, concave, and expanded.

In figure 6, with the flat substrate shown in (A), the height of slider 3 and the head gap 4 above the magnetic disc surface 5 will be identical, in other words, $H1 = H2 = 0.4$ μm. When the substrate is concave as shown in (B), the slider 3 will be $H1 = 0.4$ μm, and the head gap 4 will be $H2 > 0.4$ μm. When the substrate is convex, the slider height 3 will be $H1 = 0.4$ μm, and the head gap 4 will be $H2 < 0.4$ millimeter. Therefore, when height the floating height H2 of the head gap 4 above the magnetic disc face 5 is compared, (C) is the lowest, (A) is in the middle, and (B) is the highest.

Since the magnetic disc is read by a magnetic bundle in the head gap 4, as the distance between the head gap 4 and the magnetic disc 5 decreases, the output increases, and decomposing performance gets better. A comparison of the performance of the magnetic disc 1 in (A), (B), and (C) above reveals that (C) is the best, (A) is in the middle, and (B) is the worst.

The object of this invention is to offer a substrate for a data recording medium which is flat or convex in the radial direction using a relatively simple and easy method.

(Steps for solution)

In the field of injection molding synthetic resin substrates for data recording media, this invention is regarding a mold where the rear side of the mold cavity is hollow and the cavity can be deformed elastically by molding pressure.

(Function)

The function of this invention is explained in the following.

Figure 8 is a section of a former substrate mold 10. In this example, molten resin such as PC, PMMA, PEI, or PES is injected into a disc shaped mold cavity 15 with mirror finished bushings 13, 14 in a mold 11, 12 by an injection molding machine (not shown in the figure). Resin enters the cavity through a sprue bushing 16 and a center gate 17. Molten resin in which fills the cavity 15 is cooled and solidified. Cooling and solidification start from the surface of the substrate which is in contact with the mirror finished bushings 13, 14, and progress to the inside of the substrate as times passes. Since there is an associated reduction in the substrate volume, the surface solidifies first and the interior volume decreases after the outer shape is formed. This causes the surface to be concave in the radial direction after molding the same as figure 7 above.

A substrate mold 100 which is one example of this invention is shown in figure 1. The rear side of the mold cavity 15 is made hollow. The forming part of this mold cavity 15 can be elastically deformed by molding pressure. In this example, as shown in the enlarged figure 2, a hollow center part which consists of very small gaps is formed between mirror finished bushings 13, 14 and the cooling bushings 18, 19. The part of the substrate which faces the mirror finished bushings 13, 14 is made thin. Because of this, when resin is injected into the molding cavity 15, the mirror finished bushings 13, 14 are elastically deformed to the center hollow part by injection pressure as shown in figure 3. Therefore, when the molded substrate is cooled and solidified the mold cavity 15 will have a convex shaped surface in the radial direction as shown in figure 4 after molding and stretching and shrinking.

Also, since the amount of elastic deformation of the mirror finished bushings 13, 14 can be changed by adjusting the injection pressure, the shape of the substrate in the radial direction can be made flat as shown in figure 5.

Also, in actual practice of this invention, the hollow center part which is formed in the rear of the cavity can be extended to the OD.

This hollow center method can be realized relatively easy compared to the former case where the thickness of the molding cavity in the radial direction must be machined so that it changes gradually.

Therefore, according to this invention, it is possible to acquire a synthetic resin substrate with a flat or slightly convex surface in the radial direction by a relatively simple method. For example, when this substrate is a substrate for a data recording medium such as a magnetic disc, not only can signal loss due to a concave surface be prevented, but a data recording medium with high output can be constructed by making the surface convex.

(Example of practice)

Using the mold 10 shown in figure 8 of the former example, a substrate A for a magnetic disc was formed at a high injection molding pressure. Using the mold 100 shown in figure 1 of this invention, a substrate B for a magnetic disc was formed at low injection molding pressure and a substrate C for a magnetic disc was formed at high injection molding pressure. Substrate size was: outer diameter 130 mm; thickness 2mm.

The barrel temperature of the injection molding machine was 380°C, and the mold temperature was 190°C.

The surface shape in the radial direction and the deviation from flat (t value in figure 4) of the substrates A, B, and C are shown in table 1. Table 1 confirms that a synthetic resin substrate which is flat or convex in the radial direction can be manufactured according to this invention.

A magnetic coating was applied on each of the substrates A, B, and C using a spin coater, and magnetic discs A, B, and C were manufactured. The performance of each disc A, B, C is shown in table 2. Table 2 confirms that a magnetic disc with high output can be constructed by using a substrate manufactured according to this invention.

(Effects of this invention)

As stated above, a synthetic resin substrate which is flat or convex in the radial direction can be manufactured relatively simply and easily by the method in this invention. Because of this, a magnetic disc with high output can be formed.

4. Simple explanation of figures

Figure 1 is a section of a mold according to one example of practice of this invention.
Figure 2 is an enlarged section of the main part of figure 1.
Figure 3 is a section which shows the elastically deformed cavity in figure 1.
Figure 4 shows molded product with a convex surface according to this invention.
Figure 5 shows molded product with a flat surface according to this invention.
Figure 6 shows the floating height of the magnetic head above the magnetic disc.
Figure 7 shows molded product with a concave surface according to a former method.
Figure 8 is section which shows the former mold.

100: mold
13, 14: mirror finished bushings (cavity forming part)
15: mold cavity

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	shape	t
A former method	concave	4 μm
B this method	flat	0 μm
C this method	convex	3 μm

	I.D. (r=33mm)			I.D. (r=60mm)		
	1F output	2F output	Decomposition performance	1F output	2F output	Decomposition performance
A	1.12 mV	0.57 mV	59.8 %	2.03 mV	1.66 mV	81.8 %
B	1.20 mV	0.77 mV	64.2%	2.10 mV	1.75 mV	83.3 %
C	1.27 mV	0.85 mV	66.9 %	2.22 mV	1.88 mV	84.7 %